RESEARCH PAPER

DEVELOPING AND SUSTAINING SCHOOLS AS TECHNOLOGY-ENRICHED LEARNING ORGANIZATIONS

By

LINDA COLE ATKINSON* MARY JOHN O'HAIR** H. DAN O'HAIR*** LESLIE ANN WILLIAMS****

ABSTRACT

During the last two decades, an assumption was advanced by policy makers that making technology available would result in effective technology transfer and integration in the teaching and learning process (Cuban, 2001); however, reality has been less kind with research presenting a pessimistic picture regarding the impact of technology in the classroom and on teachers' instructional strategies (Becker, 2001). The purpose of this study was to examine how technology-enriched learning environments can be developed and sustained through Professional Learning Community (PLC) paradigms that make meaningful differences in teacher and student learning.

Key words: schools as sustainable learning organizations, leadership, professional learning communities, technology integration, change in educational practice.

INTRODUCTION

Technology plays an integral role in the United States economic, social, and political presence where the importance of a technologically literate workforce is emphasized (Culp, Honey, & Mandinach, 2003). The significance of this role is illustrated by the U.S. Department of Labor's (2006) estimate that the occupations of computer specialists will increase faster than others through the year 2014. Are our students prepared to enter this workforce? A report by business and higher education leaders indicates that students are falling short of scientific and technological literacy and are ill-prepared to leverage scientific and technological skills as participants in a democratic society (Business & Higher Education Forum, 2005). Skills that are necessary in the workforce, such as adapting to change, decision-making, and problem solving strategies, are developed by managing content within word processing, spreadsheets, and drawing programs (Cradler, McNabb, Freeman, & Burchett, 2002). To have the greatest impact on student learning, students must utilize technology as a workplace tool and the content must be an integral part of an articulated curriculum and assessment program (CEO Forum, 2001; Cradler et al.,2002; TSSA Collaborative, 2001; Wenglinsky, 2006). Research studies have provided evidence that when technology is utilized as a tool for application of content in problem-solving situations and as students transfer their learning to contexts in the real world, higher-order thinking and workforce skills are developed and student achievement also increases (Cradler et al, 2002; Roschelle, Pea, Hoadley, Gordin, & Means, 2000; Schacter, 1999; Wenglinsky, 2006).

By 1999, National Center for Educational Statistics [NCES] (2000) reported 99 percent of teachers had access to computers somewhere in the school and 84 percent had computers in the classroom. Computer use increased if the teachers had access to the computers in their classroom (Becker, 2001; NCES, 2000). Unfortunately, the digital divide seeks out all contexts. The distribution of computers and access to the Internet were not equitable among schools (NCES, 2000). Schools with lower minority enrollments were more likely to have Internet access and a greater distribution of computers. By 2003, most schools were bridging the great divide by providing students who did not have the resources available in their homes with access to the Internet and computers (DeBell & Chapman, 2006).

Teacher preparation for technology diffusion was another story altogether. In 1999, only one-third of teachers reported feeling adequately prepared to use computers for classroom instruction while the less experienced teachers feel more confident than their well experienced

peers (NCES, 2000). Becker (2001) found that professional development increased teachers' feeling of preparedness to use computers and Internet, and during this time, three-fourths of the teachers reported using technology for planning, teaching, or for e-mail (Technology Counts, 2001), while only a few teachers reported utilizing technology for word processing, providing lower-ability students content-related drills, or assigning constructivist type projects for students (Becker, 2001).

Many have questioned whether if the investment of $40 billion in federal funds and the money from the state and local agencies have created rich learning environments for students. Cuban (2001) reports that technology in schools had a minimal impact on teachers' classroom instruction. *Edtech* (2003), a Benton Foundation report, identified that districts that are successful in their implementation of technology have established a clear vision of the role of technology and provided professional development that transcends basic technology skills. The present study responds to these challenges and investigated how technology diffusion can be coupled with professional development to enrich staff development and technology integration toward the greater goal of improved student achievement.

Conceptualizing the Problem

The theoretical perspectives of the study were drawn from learning organizations and change theories as well as research-based practices that support these theories in schools. Schools as learning organizations were discussed in relation to change dynamics, leadership, and professional development. The study's conceptual framework was focused on building and sustaining organizations "where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together" (Senge, 2000, p. 3). Senge (2000) builds on Weick's (1979) premise that the process of organizing involves the interlocked behaviors of at least two people and develops a framework for learning that is based on the way people interact. Managing the complex social dynamics of learning organizations involves processes and influences of change in individuals that transform the organization into a learning community.

The learning of individuals, teams, and the organization are influenced by the capacity of the whole. An individual's learning capacity increases as personal mastery is achieved and one's mental models change. A shared vision capitalizes on the individuals' mastery and capacity. Senge (1990) states "when more people come to share a common vision, the vision may not change fundamentally. But it becomes more alive, more real in the sense of a mental reality that people can truly imagine achieving" (p. 212). Developing a shared vision involves inquiry and dialogue into complex issues. Through these social processes, such as discourse and reflection, individual or collective beliefs and assumptions may be challenged resulting in generative learning that develops new understanding and capacities (Senge, 1990; Sun & Scott, 2003). The learning resources are provided by the social groups (Brown & Duguid, 2000), and as an organization works toward achieving the shared vision, the vision becomes "a vehicle for advancing the larger story" (Senge, 1990, p. 351) through the inter-relationships of the organization as a whole.

Schools As Learning Organizations

In this age of accountability at the state and national level, many schools feel compelled to test the latest innovation or program, often dividing the efforts of the staff and fostering an atmosphere of fragmentation. This predicament suggests the need for building coherence in the organization as a dynamic system rather than approaching the challenge from linear thinking (Fullan, 2001; Newmann, King, & Youngs, 2000). System thinking builds coherence through a focus on the whole rather than the distractive lure of isolated parts, development of overall goals rather than stand alone events, consideration of the organization at different levels and between levels, and the context of its history and environmental relationships (Fullan, 2003). Systemic structures and the resulting inter-relationships are the key

variables that influence behaviars in arganizatians (Senge, 1990). Feedback: a concept of systems thinking, refers to "the process of actions reinforcing actions repeatedly, resulting in patterns that pravide meaning in the language af the arganizatian". Feedback pravides opportunities to be involved in problem-solving, to reflect about other approaches, and to collectively share the resulting actians (Brawn & Duguid, 2000). Thraugh the processes of reinfarcing feedback, even small changes can produce significant effects towards a shared vision. Seeing the organizatian as a whole and considering change pracesses are ideas from system thinking that have profound implications for professional development and influencing behaviors in schools (Senge, 1990).

Systemic Change in Learning Organizations

Change in learning organizations:

For schools to be learning organizations, school leaders need ta facus an the system and understand change pracesses and schaal cultures as camplex, living organizations. "To understand things systematically literally means to put them into a context, to establish the nature af their relatianships" (Capra, 1996, p. 27). Fullan (2003) stresses the importance of addressing the context or the conditions under which we operate, rather than accepting it. Ta change the cantext refers ta aur understanding of words, environment, ar circumstances that affect or influence the meaning of ideas or concepts, for example, identifying what is important to the arganizatian, such as callabarative gaal setting, and develop structures that facilitate these processes (Fullan, 2003).

Leadership for change:

A new type of leadership is required in schools that function as learning organizations. These leaders are "designers, stewards, and teachers. They are respansible far *building and sustaining organizations* where peaple continually expand their capabilities to understand camplexity, clarify vision, and improve shared mental madels - that, they are respansible far learning" (Senge, 1990, p. 340, emphasis in original). Research by Waters, Marzana, and McNulty (2003) stresses the impartance af the principal who leads educational reform and understands the changes that impact student achievement and what these changes require far the faculty. The principal, as the farmal leader, utilizes the concept of distributed leadership and establishes collaborative processes and structures for sharing decisian-making with teachers an substantive issues which build the leadership capacity of individuals and the organization forming a school culture that supports the develapment af learning communities (Elmore, 2000; Spillane, Halverson & Diamond, 1999)

Professional development for change.

When schaals emerge as learning arganizations, their culture has a significant impact on the prafessianal growth of individuals as well as the learning communities af the arganizatian. Prafessianal develapment based an systems thinking pramates change in these schaals and through processes and structures that involves the interconnections and relationships of all levels of the arganizatian cantribute ta the develapment af the shared vision far teaching and learning. Laucks-Harsley et al. (2003) recommended that when there is a strong callabarative enviranment and schools exhibit the characteristics af learning cammunities, prafessianal development can have an impact on school improvement. The structures and processes of the learning cammunity pravide the suppartive canditians far the collaborative and callective knowledge building of individuals and the collective faculty that enhances the capacity af the schaal (Brawn & Duguid, 2000, Newmann et al., 2000).

Far teachers ta shift their instructianal practices, professional development must provide constructive learning experiences (Loucks-Horsley, Love, Stiles, Mundry, & Hewsan, et al., 2003; Sparks & Hirsh, 1997). Teachers mare readily understand and practice constructivist methodologies when "they have classroom support for altering their practices, such as peer coaching, scripting af lessans, and team teaching" (Braaks & Braaks, 1993, p. 121). Collaborative processes that provide teachers opportunities of sharing knowledge and analysis of ideas

or strategies contribute to a collective wisdom impacting teachers' proctice (Brown & Duguid, 2000). This idea is supported by Becker and Riel's (2000) findings that there is a similarity in the way teachers' conduct themselves as teachers and the monner in which they organize their classrooms. For exomple, teachers who focus on traditional teaching strategies and have students working alone on externally driven curricula do not participate with peers in professionol activities. In contrast, teachers who are engaged in the larger professional community and participate in collaborative exchanges provide the same type of interactions for students in the classroom.

Professional Development and Technology Integration

Professional development for integrating technology in teaching and leorning involves the some processes of change as any innovation (Holl & Hord, 1987). Dwyer, Ringstaff, and Sandholtz (1991) found thot learning to use technology is an evolving process and teachers' exhibit attitudes and practices involving technology in distinct stages of use. Other researchers have identified that teachers go through similar processes as they begin using technology (Riel & Fulton, 2001; Ross, McGrow, & Burdette, 2003). Teochers' use of technology begins by trying to replicate existing strotegies and is more likely to use word-processing programs or drill and practice applicotions. As teachers become more familiar with the technology, they move to more learner-centered, project bosed activities (Ross et al., 2003). In o study of technology integrotion and the professionol development, Burns (2002) identified technology as a cotalyst for o community of practice, which "served os a vehicle for 'leorning obout learning,' o mirror in which teachers could see their best practices reflected for learning and teaching" (p. 302). Integrating technology impocts teachers' instructional strotegies and influences the way they relate to the content of courses, to colleagues, with students, and in the school community (Burns, 2002).

Understanding the environment that promotes learning provides guidelines for effective technology use. Using technology as a tool con enhonce learning by bringing real-world problems into the classroom by including activities thot are leorner- centered and involve critical thinking, feedback, reflection, revision, and provide connections to the community, scientists and other experts (Bransford, Brown, & Cocking, 2000; Burns, 2005). Roschelle et ol. (2000) anolyzed major studies of computers as learning tools and found that the achievement level of students is enhonced through computer-based applicotions that involve the students in these fundamental chorocteristics of learning. In general, the studies (Cradler et al., 2002; Roschelle et al.,2000) reveol that technology applications provide opportunities for students to construct their own knowledge by interacting with the content and by asking questions, manipuloting the dota, or taking intellectual risks. Students can participate as individuols or work in small collaborative groups, which provide the social context for learning. In a meta-analysis investigation of the effect of technology on student outcomes, Waxman, Lin ond Michko (2003) found modest, positive effects of instructional technology on teaching and learning. "The results con be generalized across o wide variety of conditions that have been investigoted os well as across student, school and study characteristics" (Waxman et al., 2003, p. 13). A key factor in implementing these ideas is providing professional development to build o collaborative learning environment that integrates technology into the curriculum and teaching strategies as in the Grants-to-Schools project.

Context

This study involved the Grants-to-Schools project funded by the Oklahoma Educational Technology Trust (OETT) with the mission of equipping public schools ond CareerTech students with the technology and technological skills necessary to compete in the global marketplace. OETT estoblished a portnership with Oklohomo - Achievement through Collaboration ond Technology Support (OK-ACTS) to provide professional development in leadership for school renewal initiatives involving professional learning communities ond technology integrotion for OK-ACTS schools. The progrom goals were occomplished in two phases. OK-ACTS Phase I provided professional development for principols and superintendents to

create learning cammunities utilizing technalagy ta impact student achievement in pasitive ways. School superintendents and principals who completed the year-lang leadership develapment were eligible ta apply for the praject.

The purpase af Phase II was ta sustain the effarts begun in OK-ACTS Phase I and to extend the professional development to involve teachers, parents, and cammunity members. The applicatian required superintendent and principals ta canceptualize programs that would improve student achievement through technology integration, professional develapment, and effective shared leadership. Thraugh the grant application process, districts or schools have developed action plans to implement three of the *10 Practices of the High Achieving Schaal* (O'Hair, McLaughlin, & Reitzug, 2000) using technalagy ta impact student achievement. For the 2003- 2004 school year, 21 schools and districts were selected through a competitive grant pracess. Campanents af prafessianal learning communities involve school leaders, teachers, students, and community members in processes to move the schaal tawards a shared visian af effective teaching far student learning. Studies have shawn that the availability of technology does not translate to use by students and teachers in the classroom. If a relationship exists between prafessianal learning cammunities and technalagy integration, these findings demonstrate important practices for today's classrooms and students' becoming technalagically literate and impacting student achievement.

Research Questions

This study examined the nature af the relatianship between professianal learning cammunities and technology integration. Three questions guided the investigation.

RQ_1: *What is the relationship between professional learning cammunities and the integratian af technalagy in the teaching and learning pracess?*

RQ_2: *What are the relatianships between the dimensians of professional learning communities and factors of integratian af technalagy far teaching and learning?*

RQ_3: *What are the lang-term effects and sustainability af the relatianship between prafessianal learning communities and the integration of technology in the teaching and learning process?*

Method

This empirical study investigated the longitudinal impact of a state-wide project that delivered prafessional develapment, callabarative netwarking, and technalagy equipment to 21 school/district staffs as they participated in learning cammunity develapment and technalagy integration. Quantitative data from teachers' pre- and past-interventian surveys were analyzed using carrelatianal analysis ta determine the nature af the relationship between dimensions of learning communities and factors of technology integration. Qualitative data fram state level perfarmance data, interviews with school administrators and teachers, classroom observations, and field notes were collected ta pravide a deeper understanding af the sustained cultural changes in the schaals.

Sample

The sample camprised af teachers and administratars in the 21 districts ar schaals wha were recipients af a 2003 Grants-to-Schools award. The school levels represented by the 21 awards included: three districts, five high schaals, ane middle schaal, and 12 elementary schaals. Fifty-three percent of the students in the sample qualified for the free and reduced lunch program, indicating high levels af paverty in the grant schaols. There were 676 teachers in the grant districts ar schaals. The sample frame was the completion of the pre and post-surveys for both instruments utilized in the study, resulting in a purpasive sample af 218 teachers.

Descriptive infarmatian gathered by the survey instruments and the grant applicatian pravided demographic data about the sample. Of the 218 teachers, 90 percent (n =197) were female and 10 percent (n = 21) were male. Three levels af schaal organizations were represented, with 21 percent (n = 46) of teachers at the secondary school level, 71 percent (n

=154) at the elementary level, and 8 percent (n = 18) representing districts. Teaching assignments varied from self-contained or subject-specific at one grade level to pre-kindergarten through twelfth grade.

The majority of the teachers (75.6 percent) had been employed as teachers for a mean of 13.57 years with the range of 41 (SD = 9.304). Data indicated that 25.8 percent of the teachers were in the first five years of teaching. This percentage decreased steadily in five year increments until reaching over 25 years in the profession. Teachers had been teaching in the current school from 1 to 33 years (M = 8.78, SD = 7.34); however, nearly half of the teachers (48.8 percent) had been teaching in the current school for one to five years.

Instrumentation

Two pre and post-intervention survey instruments, *School Professional Staff as a Learning Community* (*SPSLC*) (Hord, Meehan, Orletsky, & Sattes, 1999) and *Technology Integration* (*TI*) (SEDL, 2003) were distributed to all teachers (N = 676) in the 2003 Grants-to-School project.[1]

Professional Learning Communities Instrument:

SPSLC assessed the school's team work in the following five areas:

- the collegial and facilitative participation of the principal, who shares leadership (power and authority) in decision-making with the staff (with two descriptors);
- a shared vision that is developed from the staff's unswerving commitment to students' learning and that is consistently articulated and referenced for the staff's work (with three descriptors).
- learning that is collectively pursued to create solutions that address students' need (with five descriptors)
- the visitation and review of each teachers' classroom practices by peers including feedback and assistance that actively supports individual and community improvement (with two descriptors); and,
- physical conditions and human capacities that support such an operation (with five descriptors) (Hord et al., 1999, p 1).

Validity and reliability analyses were conducted by Appalachia Education Laboratory (AEL) (Meehan, Orletsky, & Sattes, 1997). Three types of validity analyses were conducted - content validity[2], concurrent validity[3], and construct validity[4].

Descriptive statistics were computed for the full sample of n = 690, followed by computations for the school level, elementary, middle/junior high, and high school; and finally, these results were compared to the mean scores of the 21 schools in the field test. These results indicated that the instrument did differentiate among all schools and within the subgroups of schools (Hord et al., 1999). Internal consistency reliability coefficient was computed using the Cronbach's Alpha formula and indicated satisfactory reliabilities for the full group (n = 690) was 94. The Alphas for the individual school levels ranged from .62 -.95. The stability test reliability coefficient was computed, using test-retest, on a small sample (n = 23) and was marginally satisfactory (.61). The small sample size was due to problems with matching identification numbers.

Integration of Technology:

The second instrument was the *Technology Integration (TI)* (SEDL, 2003) survey. The primary focus of the instrument was to explore teachers' and students' use of technology and the extent to which technology was integrated into

[1] *Survey instruments are available from the Oklahoma Educational Technology Trust.*

[2] *For content validity, three stages of review were conducted with minor changes in wording that met the original intent and the author's approval. It was determined that the instrument had "sufficient content validity for its original intention of measuring the concept of a community of learners within the professional staff of K-12 schools" (Hord et al., 1999, p. 7).*

[3] *A school climate instrument was administered to assess concurrent validity of the instrument. The SPSLC demonstrated concurrent validity with the school climate instrument with a correlation of .75, $p < .001$.*

[4] *For construct validity a t-test compared a known group of teachers with the teachers in the field test (n = 690). The results indicated the known group of teachers, who were known to function as a professional learning community, differed significantly ($p = .0001$) from teachers in the field test (Hord et al., 1999). Lastly, a factor analysis using an unconstrained principal components analysis followed by a varimax and oblique rotations was conducted. "Based on factor analysis results, it appears that the 17-item instrument represents a unitary construct of a professional learning community within schools" (Hord et al., 1999, p. 4).*

the classroom. The *TI* survey assessed the following factors of integrating technology in teaching and learning:

- Teachers' use of technology (five factors: teachers' use of technology for instructional purposes, planning and collaborating for technology, using technology to communicate with others, using technology for decisions about students' learning needs, and sharing practices for technology integration)
- Students' use of technology
- Support received by teachers for using technology
- Teachers' beliefs regarding use of technology (two factors: positive and negative)

The *TI* instrument served as a pre and post- survey with slight variations. The pre-survey instrument consisted of 14 questions, of which 10 were structured questions; the remaining four questions were open-ended. The open-ended questions were not included in the post-survey; therefore, the responses were not used in the data analysis. Six of the structured questions had 1 to 31 items with response choices having descriptors for the possible ratings, and were scaled from one to four or five. The choice descriptors varied from one (never) to five (daily or always); one (not at all) to five (expert); one (none) to five (total support); and one (strongly disagree) to four (strongly agree).

An exploratory factor analysis was performed on questions five through eight of the *TI* post-survey to investigate the constructs being measured by the items included under each question. The questions contained items focusing on teachers' use of technology in their work (question five), students' technology use in learning tasks (question six), the support received by teachers for using technology in their work (question seven), and teachers' general beliefs regarding technology use (question eight).

Using principle component analysis with varimax rotation, eigen values of one or greater constituted the criteria for factor extraction. For the first analysis, no factor solution was requested, resulting in an eleven factor solution. This structure was not easily interpretable, especially for items within question five. The items in a factor had to meet the .50/.30 strength and purity standard for factor loadings. Many of these items formed singular categories, others combined with some of the items in questions six through eight.

After considering the results of the initial factor analysis and looking more closely at the items in question five, a separate factor analysis was performed on this question. The result was a five factor solution suggesting subscales within this question measuring (i) providing technology-based learning activities for students, (ii) planning and collaborating for technology integration, (iii) using technology to communicate with others, (iv) using technology for decisions about student's learning needs, and (v) sharing practices for technology integration. Reliabilities calculated on these factors resulted in .95, .83, .82, .87, and .87, respectively, indicating good instrument reliability.

The next three questions elicited responses concerning students' use of technology (question six), level of support for teachers' use of technology (question seven), and teachers' beliefs about technology use in instructional practices (question eight). Factor analysis of these questions resulted in four factors. Question six reflected one factor with a reliability coefficient of .89. Also, the analysis showed question seven as one factor, with a reliability coefficient of .88. Question eight divided into two factors, reflecting teachers' beliefs regarding the use of technology, positive and negative, with reliability coefficients of .83 and .76, respectively. In summary, factor analyses generated nine constructs - the five constructs from question five: (i) providing technology-based learning activities for students, (ii) planning and collaborating for technology integration, (iii) using technology to communicate with others, (iv) using technology for decisions about student's learning needs, and (v) sharing practices for technology integration; the construct for question six - students' use of technology; the construct for question seven - level of support for teachers' use of technology; and the constructs for the two factors for question eight - teachers' beliefs about technology use in instructional practices, both positive and negative. Cronbach's Alpha for the total scale reliability is .96.

The construct validity of the survey was supported by the literature exploined above. Teachers engaged in professional development were more likely to integrate technology into the teaching and learning processes for their students (Becker & Riel, 2000; Burns, 2002). During the development of the survey, items were written ond checked by experts to see if the items reflected their understanding of technology integration. The initial survey was piloted with teachers to estoblish item relevance ond clarify. As these processes were conducted and feedback was received, items were refined (SEDL, 2003). To standordize the metric scales of all survey instrument items, Z-scores were computed and utilized for the correlation procedures. To minimize the chance of committing Type I errors by computing multiple correlations, corrected significonce levels were computed by dividing $p = .05$ by the number of correlations colculated.

Qualitative Data Analysis

Complete interview transcriptions from each teacher and administrator were analyzed through a process of organizing, reducing ond describing the dota into codes. A spreodsheet wos used to categorize the analyzed data by individual respondents, and then a composite description of the meonings of the experience was developed that represented each school site as a whole group. Interviews were conducted, transcribed, coded and themed by eoch reseorcher to provide inter-coder reliobility for the codes and themes. Participonts in the study were asked to verify the accuracy of the written interview transcriptions, codes, and themes using member checking. This trustworthiness technique of member checking established credibilify during the qualitative analysis (Lincoln & Guba, 1985). Data from state-level student performonce reports, clossroom observations, and field notes were olso onolyzed to enrich and clarify the findings. This document analysis helped to support the primary quontitative ond qualitative data sources. The narrative data were exomined for exomples of items from the primary qualitative themes ond significant correlations in the quantitative data. These dota provided a deeper understanding of how the schools hod been developed and changed.

Results

Relationship Between PLC and TI

Research Question One explored the nature of the relotionship between professional learning communities and the integrotion of technology. An overall correlation coefficient was calculated using the change score meons of the pre- and post-intervention survey results. Additionally, correlation coefficients were computed for the poired *SPSLC* (Hord et al., 1999) and the *TI* (SEDL, 2003) post-intervention surveys of professional learning communities' dimensions ond the technology integration factors. Coefficients of determinations (R^2) were computed to assess the practical significance of the correlation coefficients. The values were interpreted using Cohen's scale of .1, .3 ond .5 os small, medium, ond lorge correlotions respectively (Cohen, 1988).

The correlotion between professional learning communities and technology integration scales was significant, $r(216) = .33$, $p < .000$, $R^2 = .11$. The results of the correlations between these voriables demonstrated the positive effects of the staffs' interactions as professional learning communities and the influence on the integrotion of technology into the culture of learning for teachers ond students. Using the poired *SPSLC* and *TI* post-intervention survey results, the overall relationship between professionol learning communities and technology integrotion demonstrated o medium positive, statistically significant correlation $r(218) = .23$, $p < .05$, $R^2 = .05$. For the *SPSLC* and *TI* paired post-intervention survey responses, the correlotion coefficient was $r(218) = .32$, $p < .05$, $R^2 = .12$.

Relationships Among the Dimensions of PLC and the Factors of TI

Anolyses were conducted using the meon scores for the dimensions of professional learning communities and the factors for technology integration in order to oddress Reseorch Question Two. Correlation coefficients were calculated for change scores from the *SPSLC* (Hord et al., 1999) ond *TI* (SEDL, 2003) pre- to post-intervention surveys. For each of the analyses, o correlation matrix wos

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Leodership	—	.26	.28	.20	.40	.21*	.05	.11	.04	.12	.09	.16	.19	.10
Vision		—	.27	.21	.34	.16	.09	.01	-.07	.09	.08	.02	.11	-.10
Collective learning			—	.31	.42	.14	.04	.28*	.05	.14	.09	.17	.03	-.02
Peer review				—	.35	.31*	.09	.16	.09	.27*	.20*	.15	.24*	.05
Suppartive canditions					—	.28*	.10	.20*	.12	.18	.09	.26*	.10	.02
Instructianal						—	.41	.40	.21	.59	.56	.23	.27	-.02
Planning							—	.27	.21	.47	.28	.10	.09	.02
Cammunicating								—	.27	.35	.33	.27	.14	-.09
Decisions									—	.17	.14	.20	.06	.05
Shored practices										—	.38	.18	.16	-.06
Students' use											—	.17	.18	-.11
Suppart												—	.08	-.13
Beliefs pasitive													—	.31
Beliefs negative														—
Mean	0.05	0.03	0.06	0.12.	0.00	0.43	0.70	0.25	0.42	0.26	0.26	0.55	0.11	0.05
Standard deviatian	0.87	0.75	0.72	1.07	0.00	0.68	0.77	0.67	0.89	0.76	0.73	0.85	0.37	0.33
Range	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-4	1-4

* Correlation is significant at the corrected 0,05 level (2-tailed)

Table 1. Professional Learning Communities and Technology Integration Change Scores Correlation

structured using the dimensions of professionol learning communities ond foctors of technology integrotion. These onolyses ore presented in Toble 1.

For the doto set of the chonge scores meons from *SPSLC* ond *TI* pre-surveys to *SPSLC* ond *TI* post-intervention surveys, there were nine statistically significant correlotions listed in Toble 2.

Discussion of Findings

This study provided evidence of robust findings for

Dimensions of Professional Leorning Communities	Factors of Technology Integration
• Peer review and feedback	• Teochers' use of technology • Shoring best technology proctices • Student' use of technology • Teochers' positive beliefs obout use
• Supportive conditions	• Teochers' use of technology • Using technology to communicote • Support teochers received
• Shared leodership • Collective leorning	• Teochers' use of technology • Using technology to communicote

Table 2. Change Scores from SPSLC and TI Pre - to Post - intervention Surveys

orgonizotionol leorning through the development of professionol leorning communities ond enriching the learning environment through technology integration. The overoll relotionship of the dimensions of professionol leorning communities ond the foctors of technology integration reflects that as the schools' stoffs became more involved in the chorocteristics of professionol leorning communities, there wos o similor involvement in integroting technology into the school experiences. Likewise, the relationship demonstrated as technology wos integroted into the teoching ond leorning processes of the school, there wos o corresponding involvement in the characteristics of professional learning communities. In o study of professionol engogement ond teoching proctice, Becker ond Riel (2000) found o strong ossociotion between teochers' involvement in being leaders among peers, mentoring and providing professionol development ond their effective use of computers with students. This study's results provided empirical data to support their findings.

Not only was there a medium statistically significont overall correlation between professional learning communities ond technology integrotion, the number of stotisticolly significont correlotions using the chonge scores from pre- to post-intervention data demonstrated nine significont intercorrelations omong oll dimensions of professionol leorning communities ond six of the foctors of integrotion technology into teoching ond leorning. Through an examination of the correlations between the seporote dimensions of professionol leorning communities ond the foctors contributing to technology integration, the dimension of peer review and feedback correlated with four of the nine factors thot influenced incorporoting technology: teochers' use of technology for students' leorning activities, shoring best technology practices, students' use of technology, and positive beliefs towords the use of technology. These findings odd empiricol doto to support the study by Burns (2002) thot found professional development that integrated technology with leorner-centered approoches resulted in teochers hoving inquiry ond discourse obout best proctices for the clossroom, followed by chonging their

instructionol practices to reflect lessons thot incorporoted activities thot promoted student learning. Peer review ond feedback involved teachers in observing others' classrooms and having inquiry and discourse centered on practices or strategies observed in these clossrooms. These interactions demonstrated an atmosphere of mutual respect, provided ideos for them to use in their classrooms, and promoted the adoption of new practices (Hord, 2004). Teachers' learning was enhonced through receiving constructive feedback on specific innovations (King & Newmann, 2000). Knapp, Coplond, Ford, McLaughlin, Milliken et al. (2003) identified interactions of professionals contributing ideas of effective practices ond providing feedback as the most voluable form of professional leorning to improve practice. Findings from this study enhanced the empirical data supporting the contribution of these shared practices.

Another dimension of professional learning communities that contributed to positive associations with integrating technology was supportive conditions. Supportive conditions correlated with teachers' use of technology for instructional purposes, use of technology for communicoting with others, and the support teochers received for using technology. Supportive conditions included both the physicol and structurol foctors, such as time ond place for meetings, as well as the conditions which support the development of individual ond organizational capacities. Supportive administrators nurture the development of human capacities through promoting social processes within a caring environment. Findings from a study by Newmann, Rutter, and Smith (1989) indicated the importance of school leaders ond teachers being connected to problems ond their applicotion to current practice. Anderson and Dexter (2005) found although having the technology infrastructure is an important supportive condition, technology leadership is more influential in maximizing technology in schools. This study empirically supported the relotionship between supportive conditions, both physicol ond the conditions for humon capacity development, ond the use of the innovation of technology for instructional purposes.

The dimension of professionol learning communities, termed as 'collective learning' involved the staff in addressing issues during meaningful discussions to create challenging learning opportunities that address student needs (Hord et ol., 1999). The change score correlations demonstrated thot shoring with others in decision-making processes and learning collectively has a positive relotionship with the teachers' use of technology for students' leorning activities and using technology for communication with others. Teachers were involved in decisions for designing lessons and tasks for students utilizing technology in a variety of ways, i.e., gathering information and evaluating its occuracy, utilizing data, facilitating discussions, sharing work, and presenting their products. Technology served as o tool in communicating obout these educational issues with colleagues and administrators, as well as students, parents, and community members. The model, shown in Figure 1, describes these relationships and illustrates the integrative nature of the technology and professional learning communities.

Sustainability of the Relationships

To determine the long-term effects and sustainability for Research Question Three, data were analyzed for evidence of the significant relationships between professional learning communities and technology integration in the study schools over five years. Qualitative data from interviews, state-level student performance reports, classroom observations, and field notes were

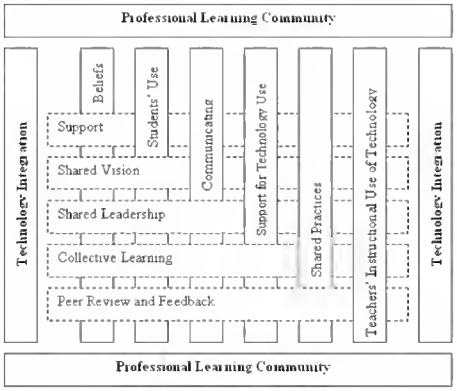

Figure 1. Schools as Technology-Enriched Learning Organizations

collected to provide a deeper understonding of the sustained cultural changes in the schools. The findings of the sustainability study were analyzed for evidence of the significant relotionships found after the first year of implementation (Homlin, 2007).

Shared leadership: Leadership, os a dimension of professional learning communities, involved processes that include the staff in discourse and shared decision-making. The mojority (20 out of 21) of the staffs' reported regulor meetings for sharing best practices, developing learning activities that promote students' use of technology, and using technology for assessment of student data. The focus of these collaborative efforts was for the technology to become integral to the instructional progrom. The colloborative learning involvement experienced by the teachers creoted positive beliefs, regarding the impoct of using technology for students' and teochers' learning.

Collective learning: The evidence gothered from the sustainability study demonstrated many examples of collective learning. Teachers and odministrators shared exomples of using technology to communicate with colleagues, administrators, students, parents, and community members. Additionally, the mojority of schools described opportunities to learn from each other, both within the school environment and externolly. In the school environment, learning from books ond observing eoch other and sharing ideos of 'what works' created increased integration of technology into the instructional doy. Beyond the local school community, stoffs opened their doors for visits from other schools, networked with other OK-ACTS schools ot the University of Oklohomo's Winter Institute, ond ottended professional development sessions provided by the K20 Center or vendor workshops.

Shared vision: In the originol grant opplicotion, shared vision was o required component of the gront applicotion process. After five yeors, the majority of schools have demonstrated a continued focus on common goals as indicated by the commitment for increasing the integration of technology into the instructionol progrom and leorning processes of the school for students, teachers, administrators, and the school communities. The majority of the OETT/OK-ACTS 2003 schools leveraged the grant funds to provide funding for additional technology equipment for the schools. Another exomple of a shared vision is the majority of the schools that utilize the technology for other purposes like after school programs for children or classes for odults. Two schools serve os examples of shifts in the vision of schools for the use of technology. One school reported to be less on its reliance on the textbooks and the other school is paperless in its communication ond record-keeping.

Peer review and feedback: The teochers' responses to the sustainability study illustrated that there were opportunities to observe others using technology and to share classroom technology proctices. These experiences encouraged teachers to use more technology and to increase students' opplications of technology for clossroom assignments. Teochers utilized the technology for organizational and instructional purposes. E-mail, record-keeping, calendars, and analyzing student assessment data are examples of the organizotional measures. Instructional uses included lessons to address the content areos of need from the assessment data, websites, video clips, power points, virtual field trips, and virtuol dissections.

Supportive conditions: The results indicated the support received by teochers, both schoo! conditions ond capacity building processes, impacted the teochers' use of technology in the classroom. All schools had estoblished provisions for maintenance and repair of the technology equipment. Some schools designated o teocher as a technology contact. One technology contact hos compiled o notebook of quick helps for the building's equipment. Seventy-one percent of the schools reported thot most of the original equipment was in use and many of the schools hod leveroged the grant funds for the acquisition of new equipment. The teachers' responses indicoted supportive conditions, such as, regulor meeting times ond book studies, creating o collaborative environment in which teachers contributed ideos about their proctices with others increasing the use of technology for students' learning tasks.

After five years, the professional learning communities in

the 2003 Grant Schools still continued to thrive. Administrators hod o significant influence on developing the culture that emphasized professional development opportunities and supportive conditions for integrating technology ond learning experiences. Teachers involved in a community of learners, provided support ond assistance to each other, incorporated activities for students through active learning strotegies more often than teachers who used troditionol teaching practices (Becker & Riel, 2000; Burns, 2002). The first year of the project provided empirical findings that supported these studies, ond the sustainability results confirmed the long-term impact on the learning culture of the schools and student achievement. As the teachers and school leaders utilized the technologies and shored best practices, communities of practice developed facilitating the inquiry and discourse of technology integration to impact student learning (Cate, Voughn, & O' Hair, 2006; Printy, 2004). Also, the dato indicated relationships between the professionol leorning community's characteristics of shared leadership and shored vision and the teacher's positive beliefs about the use of technology.

Analysis of School Performance Index

One meosure of a school's progress toward its educational goals is the Stote's occountability measure, Academic Performance Index (API), a formula for determining Adequate Yeorly Progress os required by NCLB. In Oklahoma, the API index formula vories by school level. For elementary schools, the API is based on student achievement data (90 percent) ond attendonce (10 percent). For secondary schools, the formula includes other foctors, such os, graduotion rote ond dropout rote, with 80 percent based on student achievement data. As a part of the gront application, the schools provided their 2002-2003 score. The 2003-2004 API scores were obtained from the School Report Card (Education Oversight Board, 2003, 2004) and compared to the 2002-2003 scores.

As shown in Table 3, the schools receiving the treatment in this study had an 82% greoter increase in the schools' API than the state average increase. When analyzing the school's API scores over the five years of the longitudinal study, continued growth and increased student achievement was evident. Eighty-two percent of the schools, which hove 50% or more poverty level, hove continued to hove an API thot is greoter than the stote averoge throughout the five years of the study.

Limitations of the Study

The pre-and post-intervention survey instruments utilized in this study relied on self-reported data from the participating teachers and administrators. The surveys' response formats utilized a five-point Likert scole producing nominal data. In the data analysis procedures, the data were treated as continuous, interval data (Punch, 2003). As the scores on the five-point Likert scale aggregated toward the higher scores on the post-intervention surveys, there was less variation in the scores (regression towords the mean or the tendency of extremes to revert toword averages).

The porticipants were drawn from a purposive somple from the accessible populotion of 2003 Grants-to-Schools recipient schools and/or districts. This fact may limit the generalizability of the findings of the study. The schools investigated in this study hod voriability in school size, length of time principal or superintendent had served in the school, varied career and professional development experiences, community and school demogrophics, and community support; however, all administrators of the districts or schools for the year of the gront implementation hod the common experience of the OK-ACTS Phase I Leodership Development. Ten of the twenty-one schools had a new administrotor sometime over the five years since receiving the grant. Seventy-five percent of these new school leoders hod become o qualified OK-ACTS Phase I leader.

School	API Pre Intervention	API Past Intervention	Chonge (Percent Increose)	Percent Comparisan of Increase
2003 - 2004 Gront Schools	1086	1161	75 (6.9%)	
State of Oklahoma	1046	1086	40 (3.8%)	
				82% greoter increase thon the state increase

Table 3. Study Schools' Academic Performance Index

Conclusion & Implications for Practice

With the *No Child Left Behind* legislation thot has increased accountability measures for student learning and the increased demand for technology literacy, schools ore faced with the dilemma of meeting these demonds while facing the various pressures that exist in today's schools. This quantitative study's results provided evidence of a model that addressed these demanding and daunting mandotes. The voriables in this study were the dimensions of professionol learning communities ond the factors of technology integration. A link has been estoblished between schools that exhibited the characteristics of professional learning communities ond improved student achievement (Lee & Smith, 1994; Morrissey, 2000; Newmann & Wehlage, 1995). In a corresponding foshion, a meto-onolysis of research studies investigoted the impact of technology use on student achievement with findings that indicated small to modest, positive effects of using technology for teaching and learning (Waxmon et al., 2003). Yet, the overwhelming evidence provided by numerous studies and reports (Becker, 2001; Cuban, 2001; NCES, 2000) was that the actual use of technology in teaching ond learning has not kept pace with the availability of technology in the classroom. The findings from this study demonstrated a moderote, positive associotion between the chorocteristics of professional leorning communities and the factors contributing to the integration of technology in the teaching ond leorning process.

The role of the school administrator was vital to this process. Senge (1990) described school leaders as being responsible for creoting an environment for learning so people can continue to learn. The formal role of school leaders estoblished structures for shared decision-making and the development of o shared vision for the school and built o commitment towords accomplishing the shored vision (Porter, 2005). As the staffs' interactions become more colloborotive, the influence of their decision making and leodership impacted teaching ond learning. Further study results indicated that schools staffs' involvement with the characteristics of professional leorning communities the factors of technology integration produced changes in the dimensions ond factors. In proctical terms, as teachers and administrators were learning about learning community processes and the uses of technology for teaching and leorning, inquiry and discourse about one varioble leod to the other variable and in the opposite direction. Consequently, school odministrators should move their stoffs toword implementing the proctices of professionol learning communities and technology thot are focused on accomplishing the school's vision.

Learning opportunities for teachers and administrators must address adult learning principles (Elmore, 2000). Loucks-Horsley et al. (2003) found thot for adult learning to be effective, the topic should be relevont, useful immediately, experiential, and have opportunities for application of leorning. The *Concerns Based Adoption Model* (*CBAM*) (Hall & Hord, 2001) provided a process of accessing the concerns the teachers or administrators had about the innovation being adopted. From these assessments appropriate professional development can be planned and acknowledge individuol's level of concern about the innovation. Following the *CBAM* model, a similar model was developed for technology integration (Dwyer et al., 1991). The chonge process moves from learning about the basic aspects of the technology, to using technology for traditional instruction and student production of existing classroom octivities, to creating new learning experiences, and finolly, ofter over 80 hours of training and 4-5 years, teachers reflecting about their fundamentol perceptions of instruction. School leaders should be awore of the progression of change characteristics for planning and supporting the change efforts.

To support teachers in learning and increasing the capacity of the organization, "professionol development should address three dimensions of school capacity-teachers' knowledge, skills, and dispositions; the strength of the school wide professional community; ond the coherence of the school progrom" (King & Newmann, 2000, p. 576). Through this development not only has the individual grown, but the capacity and relationships within the orgonization have been promoted. As teachers ond

administrators developed new knowledge, skills, and dispositions about the role of technology or the dimensions of professional learning communities, the capacity of the organization also increased. This study provided evidence of "mutually reciprocal relationships" (Williams, L. A. Atkinson, L.C., Cate, J.M., & O'Hair, M.J. (2008) between professional learning community development and technology integration that impacts organizational learning and student achievement. Through constant support and job-embedded professional development, school communities continued to improve and technology-enriched learning communities were sustained.

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ABOUT THE AUTHORS

* Associate Director for K12 Partnerships, K20 Center for Educational and Community Renewal, University of Oklahoma
** Vice Provost for School and Community Partnerships & Director of the K20 Center for Educational and Community Renewal, University of Oklahoma
*** Presidential Professor & Director of the Center for Risk and Crisis Management, University of Oklahoma
**** Associate Director for K12 Research, K20 Center for Educational and Community Renewal, University of Oklahoma

Dr. Linda Atkinson is Director of K2 Partnerships, for the University of Oklahoma's K20 Center. She has been an educator over thirty years serving as a secondary science teacher, site administrator, district curriculum director, and university professor. Dr. Atkinson is actively involved in state, national, and international science leadership and serves as President of the National Science Education Leadership Association. Her research interests are centered on interactive learning organizations and the role of technology integration in teaching and learning processes to improve student achievement, especially in the STEM areas.

Dr. Mary John O'Hair is Vice Provost for School and Community Partnerships and professor in the Department of Educational Leadership and Policy Studies at the University of Oklahoma. In addition, Dr. O'Hair is founding director of the University of Oklahoma's K20 Center which serves as a statewide, interdisciplinary educational research and development center and a conduit between university and industry researchers and over 500 schools and communities in Oklahoma. Receiving over $43 million in external funding from federal, state, and private sources, the K20 Center has made significant progress in developing and sustaining systemic substantive changes impacting student learning throughout Oklahoma. Dr. O'Hair has published numerous articles and books on professional learning communities, leading systemic change, and organizational learning and serves on Microsoft's U.S. Partners in Learning (PiL) Board of Advisors and is a research advisor for the National School Reform Faculty.

Dr. H. Dan O'Hair served as the President of the National Communication Association, the world's largest and oldest professional association devoted to the study of communication in 2006. He has published over eighty research articles and scholarly chapters in risk and health communication, business communication, management, and psychology journals and volumes, and has authored and edited fifteen books in the areas of communication, risk management, health, and terrorism. He has been the principal investigator or Co-PI for several grants from business, non-profit, and government institutions totaling more than $5 million, has served on the editorial boards of twenty-seven research journals, and is a past editor of the Journal of Applied Communication Research, published by the National Communication Association.

Dr. Leslie Ann Williams is a research associate professor in the Department of Educational Leadership and Policy Studies and Associate Director of K-12 Research at the K20 Center at the University of Oklahoma. Dr. Williams has been a Co-PI for over $27 million in grants supporting K12 school improvement in Oklahoma and has been an educator for over 15 years, serving as a secondary mathematics teacher, middle school principal, district curriculum director, and university professor.